ROOF RAT DEPREDATIONS ON *HIBISCADELPHUS* (MALVACEAE) TREES

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INTRODUCTION

The genus *Hibiscadelphus* Rock (Malvaceae) is endemic to the Hawaiian Islands. It is one of the world's rarest (genera) groups of trees. Of six described taxa, *H. bombycinus* Forbes (1920), from the island of Hawai'i, and *H. wilderianus* Rock (1911), from the island of Maui, are believed to be extinct. *H. hualalaiensis* Rock (1911), from the island of Hawai'i, and *H. distans* Bishop and Herbst (1973), from the island of Kaua'i, still survive in the wild but both species are few in numbers.

H. giffardianus Rock (1911), from the island of Hawai'i, the type species for the genus, is extinct in the wild but four trees are growing under cultivation in arboreta, and seven others are growing in the type locality in Kipuka Puaulu (Bird Park) in Hawaii Volcanoes National Park.

A hybrid, *H.* X *puakuahiwi* Baker and Allen (1976, 1977) originated in Kipuka Puaulu where its parent species, *H. giffardianus* and *H. hualalaiensis*, grow in close proximity. The hybrid has been cultivated widely in arboreta and in private gardens around Hawai'i.

It was during observations on the damage to a number of *Hibiscadelphus* trees by roof rats, *Rattus rattus* L., that the hybrid trees were discovered in 1973. This series of observations on rat utilization of bark, buds, flowers, nectar, and seed pods followed that initial study.

Feeding on bark

Roof rats were sporadically observed feeding on bark on three trees in close proximity to one another in Kipuka Puaulu. Two of these trees are *H. giffardianus* and the third a hybrid. Bark feeding on trees was first noticed in the late 1960's when a number of major limbs were girdled and killed on the oldest of the living *Hibiscadelphus* trees. Efforts were made at that time to control the problem by placing rat guards around some of the limbs; by poisoning the rats with warfarin; and by catching them in snap traps. Warfarin was the most successful control technique.

Bark consumption in ensuing years seems to have occurred principally during summer dry seasons when it is believed that the soft, succulent bark was consumed largely for its moisture content.

Feeding on nectar

Nectar feeding was found to occur largely on flowers of H. giffardianus and hybrid trees, probably because of their larger flowers and quantities of nectar. Nectar feeding was not observed on any of the smaller blossoms of H. hualalaiensis and H. distans.

In order to reach nectar deep within the tubular corollas of the larger flowered species, rats chew holes through the base of the calyxes. The feeding on flower nectar occurs in all parts of the trees, even out on twigs the diameters of match sticks in the upper reaches of the canopy, demonstrating the agility of roof rats.

In April and May 1976, we examined 317 flowers from a F_1 hybrid tree for evidence of nectar feeding. A total of 239 (75%) were rat damaged. We also examined 1967 flowers in June through August of which 538 (27%) were rat damaged. Then in March through May 1977, we determined that of 1525 flowers observed 977 (64%) were damaged. In June, 412 of 590 (69%) flowers examined were also damaged. In total, 4399 flowers were examined and 2164 (49%) were found to have been fed upon by rats.

Feeding upon buds and flower parts

Roof rats also eat the staminal column which includes the anthers and pollen. They not only eat the staminal column of mature blossoms, but they will also chew open buds to reach the anthers and pollen inside. Most of what we observed of this feeding behavior occurred in April and May 1976, when we noticed that 68 (21%) out of 317 blossoms had missing staminal columns.

It appears that rats are after the relatively large amounts of pollen present. Individual pollen grains in Hibiscadelphus are large, up to 220μ, which can be seen easily with the naked eye. We smeared and dried quantities of pollen and then stained them with ninhydrin producing a deep, purple-colored response indicating the presence of relatively large amounts of amino-acids (after the staining techniques of Baker and Baker, 1973). The nectar also stains a deep purple, more so than nectars of any other native Hawaiian flower we have analyzed so far. This may suggest that the pollen and nectar of Hibiscadelphus is especially nutritious both to rats and bird utilizers.

Feeding upon seed pods

Immature seeds are normally consumed. Each of the five carpels is opened and the two to five seeds present removed. Only the endosperm of the seeds is eaten; the outer husk is discarded. In 1976, we placed a 1 m^2 seed catching tray under the canopy of a hybrid tree for 30 days and collected the husks of approximately 150 seeds. A total of 21 uneaten seeds were present, obviously dropped by the rats, indicating an 88% destruction of the seed crop during this one period of observation.

There is an obvious difference in the seed feeding habits between two particular rat populations feeding on two different but nearby trees. On one tree the empty pods are left dangling by their peduncles, indicating the rats feeding in that tree are eating the seeds, in situ. On the other tree the rats chew through the peduncle and carry the pod down the tree to a nearby feeding station. A cache of 136 empty seed pods was found in this feeding area in 1976, and another 120 pods were found in 1977.

We estimated that the total 256 fruits destroyed represented about 90% of the total seed production, and that about 3000 seeds were eaten in the two seasons of seed production.

Also, in 1976, we estimated that there were about 300 empty pods in a large cache found near the base of one of the two living H. hualalaiensis trees on Mt. Hualalai. It appeared that all of the remaining pods would be taken for a total destruction of that year's seed crop.

SUMMARY

All of our observations indicate that roof rats cause serious damage to Hibiscadelphus trees by eating bark, buds, flowers, nectar, and seeds, and one has to consider the possibility that introduction(s) of roof rats into Hawai'i sometime around the mid-1800's may have been an additional reason, among several, for the present rarity of these trees. Indications are that as much as 50% or more of the flowers on a tree, and as much as 90% of the seed crop, may be destroyed.

The climbing agility of roof rats in Hibiscadelphus trees suggests that these non-native animals are capable of foraging in a similar manner through the canopies of any native tree, and that the nectar feeding habits of the rats probably compete with native nectar feeding birds.

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